CLAIMS

WHAT IS CLAIMED IS:

1   1.   A method of copying data, comprising operations of:

2   receiving a request to copy a body of source data to specified target storage;

3   reviewing contents of the source data to identify data objects therein;

4   for each identified data object, performing copy operations comprising:

5   consulting prescribed metadata records to determine whether a copy of the

6   identified data object already exists in the target storage;

7   only if a copy does not already exist, performing operations comprising:

8   applying prescribed criteria to determine whether the identified data

9   object qualifies for copying;

10   forming a copy of the identified data object in target storage,

11   comprising:

12   if the data object qualifies for copying, writing the data object to

13   the target storage;

14   if the data object does not qualify for copying, instead of writing

15   the data object writing a predetermined bit pattern to the

16   specified target storage;

17   responsive to completion of the forming operation, updating the

18   metadata records to indicate that the data object exists in the

19   specified target storage regardless of whether the data object

20   was replaced with a predetermined bit pattern rather than being

21   physically written to the specified target storage.

1   2.   The method of claim 1,

2   the reviewing operation comprising reviewing contents of the source data to identify

3   individual data objects therein, and also reviewing any aggregate data objects

4   in the source data to identify all constituent data objects thereof;

5   where the applying and forming operations are performed separately for each data

6   object whether in individual or aggregated form;

7   where the operation of updating the metadata records comprises,

8   for each data object comprising an individual data object, preparing a record

9   indicating that the data object exists in the specified target storage

10   regardless of whether the data object was replaced with the

11   predetermined bit pattern rather than being written to the specified

12   target storage;

13   for each data object comprising an aggregated data object, preparing a record

14   indicating that the data object exists in the specified target storage

15   regardless of whether any constituent data objects were replaced with

16   the predetermined bit pattern rather than being written to the specified

17   target storage.

1   3.   The method of claim 2, for each data object comprising an aggregated data object,

2   further comprising one of the following operations:

3   forming a record indicating whether the aggregated data object contains any

4.   constituent user files replaced with the predetermined bit pattern;

5   forming a record specifically identifying any constituent user files replaced with the

6   predetermined bit pattern.

1   4.   The method of claim 2, further responsive to completion of the forming operation,

2   performing operations comprising preparing a metadata record to identify each individual

3   data object that was replaced with a predetermined bit pattern rather than being written to

4   target storage.

5.   The method of claim 2, the operations further comprising:

    receiving a request to restore one or more specified data objects from the target

        storage to a specified restore site;

    for each specified data object, performing restore operations comprising:

            consulting the metadata records to identify one or more copies of the specified

6   data object in the target storage;

7   if the specified data object is an individual data object, searching the metadata

8   records to locate a copy in which the data object was not replaced with

9   the predetermined bit pattern;

10   if the specified data object is an aggregate data object, searching the

11   metadata records to locate copies of the constituent data objects in

12   which the constituent data objects were not replaced with the

13   predetermined bit pattern;

14   copying each copy located by the search to a specified restore site.

1   6.   The method of claim 1, the applying operation comprising one or more of the

2   following:

3   consulting a previously prepared record designating data objects as qualifying or not;

4   applying prescribed criteria to characteristics of the data object to determine whether

5   the data object qualifies or not.

7.   The method of claim 1, further comprising reclaiming space in the copy by performing

the reviewing, applying, and forming operations to the copy.

8.   A signal-bearing medium tangibly embodying a program of machine-readable

instructions executable by a digital processing apparatus to perform operations to copy data,

comprising:

         receiving a request to copy a body of source data to specified target storage;

5   reviewing contents of the source data to identify data objects therein;

6   for each identified data object, performing copy operations comprising:

7   consulting prescribed metadata records to determine whether a copy of the

8   identified data object already exists in the target storage;

9   only if a copy does not already exist, performing operations comprising:

10   applying prescribed criteria to determine whether the identified data

11   object qualifies for copying;

12	forming a copy of the identified data object in target storage,
13	comprising:
14	if the data object qualifies for copying, writing the data object to
15	the target storage;
16	if the data object does not qualify for copying, instead of writing
17	the data object writing a predetermined bit pattern to the
18	specified target storage;
19	responsive to completion of the forming operation, updating the
20	metadata records to indicate that the data object exists in the
21	specified target storage regardless of whether the data object
22	was replaced with a predetermined bit pattern rather than being
23	physically written to the specified target storage.

9. The medium of claim 8,

the reviewing operation comprising reviewing contents of the source data to identify

individual data objects therein, and also reviewing any aggregate data objects

in the source data to identify all constituent data objects thereof;

where the applying and forming operations are performed separately for each data

object whether in individual or aggregated form;

where the operation of updating the metadata records comprises,

for each data object comprising an individual data object, preparing a record

indicating that the data object exists in the specified target storage

regardless of whether the data object was replaced with the

11   predetermined bit pattern rather than being written to the specified

12   target storage;

13   for each data object comprising an aggregated data object, preparing a record

14   indicating that the data object exists in the specified target storage

15   regardless of whether any constituent data objects were replaced with

16   the predetermined bit pattern rather than being written to the specified

17   target storage.

10.   The medium of claim of claim 9, the operations further comprising, for each data object comprising an aggregated data object, one of the following operations:

      forming a record indicating whether the aggregated data object contains any constituent user files replaced with the predetermined bit pattern;

      forming a record specifically identifying any constituent user files replaced with the predetermined bit pattern.

1   11.   The medium of claim 9, further responsive to completion of the forming operation,

2   performing operations comprising preparing a metadata record to identify each individual

3   data object that was replaced with a predetermined bit pattern rather than being written to

4   target storage.

1   12.   The medium of claim 8, the operations further comprising:

2   receiving a request to restore one or more specified data objects from the target

3   storage to a specified restore site;

4   for each specified data object, performing restore operations comprising:

5   consulting the metadata records to identify one or more copies of the specified

6   data object in the target storage;

7   if the specified data object is an individual data object, searching the metadata

8   records to locate a copy in which the data object was not replaced with

9   the predetermined bit pattern;

10   if the specified data object is an aggregate data object, searching the

11   metadata records to locate copies of the constituent data objects in

12   which the constituent data objects were not replaced with the

13   predetermined bit pattern;

14   copying each copy located by the search to a specified restore site.

1   13.   The medium of claim 8, the applying operation comprising one or more of the following:

2   consulting a previously prepared record designating data objects as qualifying or not;

3

4   applying prescribed criteria to characteristics of the data object to determine whether

5   the data object qualifies or not.

1   14.   The medium of claim 8, further comprising reclaiming space in the copy by performing

2   the reviewing, applying, and forming operations to the copy.

1   15.   A logic circuit of multiple interconnected electrically conductive elements configured

2   to perform operations to copy data comprising:

3 receiving a request to copy a body of source data to specified target storage;

4 reviewing contents of the source data to identify data objects therein;

5 for each identified data object, performing copy operations comprising:

6 consulting prescribed metadata records to determine whether a copy of the

7 identified data object already exists in the target storage;

8 only if a copy does not already exist, performing operations comprising:

9 applying prescribed criteria to determine whether the identified data

10 object qualifies for copying;

11 forming a copy of the identified data object in target storage,

12 comprising:

13 if the data object qualifies for copying, writing the data object to

14 the target storage;

15 if the data object does not qualify for copying, instead of writing

16 the data object writing a predetermined bit pattern to the

17 specified target storage;

18 responsive to completion of the forming operation, updating the

19 metadata records to indicate that the data object exists in the

20 specified target storage regardless of whether the data object

21 was replaced with a predetermined bit pattern rather than being

22 physically written to the specified target storage.

1 16. A data storage system, comprising:

2 digital data storage including a body of source data;

3   metadata;

4   a storage director, programmed to perform copy operations comprising:

5   receiving a request to copy a body of source data to specified target storage

6   of the digital data storage;

7   reviewing contents of the source data to identify data objects therein;

8   for each identified data object, performing copy operations comprising:

9   consulting the metadata to determine whether a copy of the identified

10   data object already exists in the target storage;

11   only if a copy does not already exist, performing operations comprising:

12   applying prescribed criteria to determine whether the identified

13   data object qualifies for copying;

14   forming a copy of the identified data object in target storage,

15   comprising:

16   if the data object qualifies for copying, writing the data

17   object to the target storage;

18   if the data object does not qualify for copying, instead of

19   writing the data object writing a predetermined bit

20   pattern to the specified target storage;

21   responsive to completion of the forming operation, updating the

22   metadata to indicate that the data object exists in the

23   specified target storage regardless of whether the data

24   object was replaced with a predetermined bit pattern

25   rather than being physically written to the specified target

26   storage.

1   17.   A data storage system, comprising:

2   first means for storing digital data including a body of source data;

3   second means for storing metadata;

4   third means for copying data of the digital data storage by:

5   receiving a request to copy a body of source data to specified target storage

6   in the first means;

7   reviewing contents of the source data to identify data objects therein;

8   for each identified data object, performing copy operations comprising:

9   consulting the second means to determine whether a copy of the

10   identified data object already exists in the target storage;

11   only if a copy does not already exist, performing operations comprising:

12   applying prescribed criteria to determine whether the identified

13   data object qualifies for copying;

14   forming a copy of the identified data object in target storage,

15   comprising:

16   if the data object qualifies for copying, writing the data

17   object to target storage;

18   if the data object does not qualify for copying, instead of

19   writing the data object writing a predetermined bit

20   pattern to the specified target storage;

21   responsive to completion of the forming operation, updating the

22   second means to indicate that the data object exists in

23   the specified target storage regardless of whether the

24   data object was replaced with a predetermined bit pattern

25   rather than being physically written to the specified target

26   storage.